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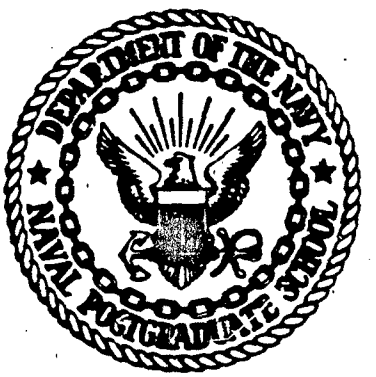
Monterey, California



ATTRITION IN THE ALL VOLUNTEER FORCE:

A PREDICTION MODEL FOR NON HIGH SCHOOL GRADUATES

James S. Blandin

March 1980

NAVAL POSTGRADUATE SCHOOL
Monterey, California

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FY74 and FY75 Army enlistment data on non prior service, non high school graduates were used to estimate the parameters of both a grouped linear and grouped logistic attrition probability assessment model based on individual demographic attributes. Both models yielded consistent results finding signigicant inverse relationships between years of education, age and AFQT group standing and the dependent variable - probability of attrition. The models were then tested using FY76 data. Both model forms did equally well in terms of →

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#20--prediction and both did a better overall prediction of job as compared to using either education level or AFQT group as the sole selection criterion. The implications of the analysis are discussed in terms of the relative expected value of alternative recruiting cost/attrition risk tradeoffs between different labor market segments.

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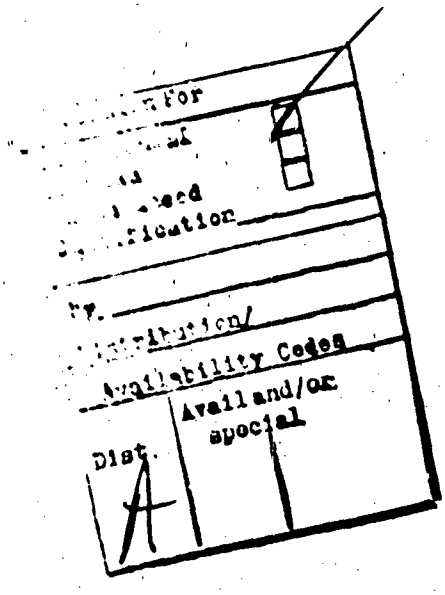

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The ability of the Department of Defense (DoD) in general and the Army in particular to recruit a sufficient number of qualified men and women into the enlisted active force in 1980's and 1990's represents a major manpower issue under the All Volunteer Force (AVF) concept. In a recent assessment of the AVF, two authors conclude that if present practices continue the DoD will not be able to recruit and retain in terms of both quantity and quality a future force level of two million persons, especially in the combat arms.[1] Uncertainty over the future viability of the AVF in large part is driven by emerging demographic trends. Current projections show the number of men in the 17-21 year age group declining by 17% in the 1978-1990 time period.[2] While the full impact of this trend on the public/private sector competition for youthful workers, youth unemployment rates and relative wages is not precisely known, it will no doubt make recruiting and retention more problematic for the DoD in the decade ahead.

In response to these emerging trends, a number of new policy formulations have already taken shape. For example, each of the services has examined ways in which women may be substituted for men in certain occupational groups. From FY70 through FY78 the percentage of women in the enlisted active force has increased from 1% to 6% and is projected to exceed 11% by FY84.[3] Other alternatives designed to increase recruiting flexibility to insure that adequate enlisted supply exists to meet DoD manpower demands include civilian substitution, relaxation of certain entry standards, and the use of better initial screening methods in an attempt to reduce first term attrition. This research will focus on the issue of managing enlisted attrition.

Selection research and manpower policy directed at reducing first term attrition have focused on two related issues. First, over a decade of research effort has been directed to the problem of trying to identify predictors that are associated with individual success in completing one full enlisted tour. The general conclusion that results from this research is that level of education, mental ability and age are all positively related to success in completing the first term.[4,5,6] The potential benefits of reducing first term attrition through better selection methods based on these research findings are impressive. For example, the Defense Manpower Commission estimates that the DoD incurs an annual cost close to $1 billion because one out of four accessions is involuntary separated prior to completing his first term.[7] A second policy area which has gained increased attention in recent years involves the recruiting in labor market segments which historically have not been heavily recruited. Increased substitution of women for men in selected occupational groups across all services provides a recent example. In part, DoD manpower yields in the years ahead will depend on how effectively the DoD recruits in each potential labor market segment.

Since the Army has been the major recruiter in the non-high school graduate non-prior service (NHSG-NPS) market segment since the AVF was established, we chose to examine their recruiting experience in FY74, FY75, and FY76. The specific objectives of the research were twofold. First, the research sought to develop a predictive model to aid in identifying low attrition risk individuals (good bets) in the NHSG-NPS market segment. Second the study attempted to evaluate the relative effectiveness of the model against two historically well known screening heuristics; the use of educational level and Armed Forces Qualification Test Group (AFQTG) ratings.

THE NHSG-NPS LABOR MARKET SEGMENT

> "It is generally accepted that possession of a high school diploma is the best single measure of a person's potential for adapting to life in the military. High school graduates are more likely to complete their terms of service than are their contemporaries who have not received a high school diploma. Thus, active forces recruiting programs have concentrated on enlisted high school diploma graduates"[8]

> "Sweeping statements and generalizations are made about population categories which often number in the millions. We hear statements such as: "college youth today" or "young women want" or "Black adolescents seek" or "middle class youth are experiencing..." and "todays Marines want". Obviously there is a need for more in the way of multi-variate analysis and much more in the way of caution in bridging between limited samples to massive population-projections'[9]

As indicated in Table 1, individuals who do not have a high school diploma attrit at twice the rate of high school diploma holders. As long as high school diploma holders are in relatively abundant supply one can reduce the expected cost of early attrition by recruiting heavily from this population. Especially for Army, however, enlisted manpower demand has not been met solely from the high school graduate segment. Recent estimates put the percentage of high school diploma graduates for the Army currently to be slightly less than two thirds of their total accessions.[10] If this estimate is correct and continues, in FY80 the Army will enlist approximately 35% or 46,000 individuals from the non-high school graduate segment. If the historic average attrition rates in Table 1 hold, in FY80 between 30 - 40% or 13,900-18,400 individuals will not successfully complete their first term. The size of the problem is therefore neither small nor the direct and indirect cost impacts of premature attrition minimal. While estimates vary, one author

TABLE 1

MALE AND FEMALE ENLISTED PERSONNEL, ALL MILITARY SERVICES: ATTRITION RATES DURING FIRST TWO YEARS OF MILITARY SERVICE— BY SEX AND EDUCATIONAL LEVEL

(FISCAL YEARS OF ACCESSION: 1971-1974)

EDUCATIONAL LEVEL	PERCENT ATTRITION BY YEAR OF ACCESSION			
	FY 1971	FY 1972	FY 1973	FY 1974
MALE				
TOTAL	20.7	21.3	23.6	29.1
HIGH SCHOOL GRADUATES	14.3	15.5	17.1	19.9
NON-HIGH SCHOOL GRADUATES*	32.2	32.4	35.2	41.7
FEMALE				
TOTAL	40.8	35.1	30.8	28.7
HIGH SCHOOL GRADUATES	39.6	33.9	29.9	27.0
NON-HIGH SCHOOL GRADUATES*	60.3	55.6	48.2	47.0

SOURCE: DEFENSE MANPOWER DATA CENTER TABULATIONS FROM COHORT FILE.
*INCLUDES THOSE WITH GED CERTIFICATES.
NOTE: INDUCTEES ARE NOT INCLUDED.

claims the Army has invested $5,100 in an individual by the end of advanced individual training.[11] To this direct investment cost must be added the cost of additional recruiting needed for replacement, the indirect costs of unit turbulance, as well as the increased judicial/medical/adminsitrative effort required to separate the individual. Therefore, any improvement to reduce premature attrition in an already attrition prone market segment through better selection could have a significant positive impact for the Army in terms of both reduced attrition costs and reduced net long run manpower requirements.

SAMPLE

The sample used in the study consisted of NHSG-NPS males who enlisted in the Army in FY74, FY75, and FY76. Data was provided by the Defense Manpower Data Center, Monterey, California. Usable observations numbered 66,902 in FY74; 53,574 in FY75; and 57,904 in FY76. These NHSG-NPS individuals represented approximately one third of total Army enlisted accessions over the time period.

The FY74 to FY76 groups were chosen for two principle reasons. First, the FY74 group represented the first full year of AVF experience and as such there were no draftees. Second, there were reasonable enlistment attrition statistics for those individuals who enlisted in FY76. For each individual, data on the following data elements were available at time of initial enlistment: (1) Census Region; (2) Age; (3) Highest year of education completed; (4) Sex; (5) Race; (6) Armed Force Qualification Test Groups (AFQTG); (7) Month entered; (8) Marital status.

For this study attrition was defined as being released from active service prior to the end of a first enlistment tour because of failure to

meet minimum behavioral or performance criteria.[12] Individuals who attrited for behavioral or performance reasons accounted for 51.4% of the FY74 sample, 48.8% of the FY75 sample and 38.3% of the FY76 sample. While these figures may imply a reduction in attrition over the time period FY74 - FY76 it must be noted that relative to those enlisting in FY74 or FY75 fewer of the enlistees in FY76 had reached the end of their first term enlistment obligation. It is reasonable to expect that the 38.3% attrition figure for the FY76 cohort will increase as a function of time.

As a first step in the data examination, a chi square analysis was performed in order to determine which variables were independently associated with the dependent variable, attrition/non-attrition. This information was in turn used to make a number of judgements concerning which variables would be selected for use in the model. For example, females were dropped from the analysis because of low frequency counts. This preliminary analysis also suggested that a number of variable categories be combined because of their consistency of association over time with the dependent variable. Table 2 presents the variables used to build predictive model.

MODEL AND METHODOLOGY

The next task was to link the previously identified attributes of NHSC-NPS individuals to the observed attrition rates so that the importance of the individual attributes could be tested statistically and predicted attrition rates could be calculated. It was initially decided that the data from FY74 and FY75 would be used to estimate the model's parameters. The model would then be tested using FY76 data so that an independent evaluation could be made comparing predicted non-attrition yields against what the actual yields would have been had the model been used for selection.

TABLE 2

MODEL VARIABLES

1. Race - Two categories: (1) Caucasian (2) Non-Caucasian.
2. Highest Year of Education - Two categories: (1) Less than or equal to two years of high school; (2) Three or four years of high school with no diploma.
3. Month Entered - Two categories: (1) January - June (2) July - December.
4. Age - Four Categories: (1) 17; (2) 18; (3) 19; (4) 20 and 21 years.
5. Census Region[13] Ten categories: (1) New England; (2) Mid Atlantic; (3) E. North Central; (4) W. North Central; (5) S. Atlantic; (6) E. South Central; (7) W. South Central; (8) Mountain; (9) Pacific; (10) Other.
6. Armed Forces Qualifying Test Groups (AFQTG) - A classification test designed to determine general mental ability. Four categories (listed lowest to highest mental ability):
   (1) AFQTG IVa; (2) AFQTG IIIb; (3) AFQTG IIIa; (4) AFQTG's I and II.

The fundamental model relationship was expressed as,

(1) $P = f(x)$

Where,

P = probability of non-attrition

and

x = a vector of enlistee attributes

To be empirically useful, of course, this general relationship must be expressed as a statistical model. The remainder of this section addresses a number of issues encountered in formalizing such a model.

First, although the scale of measurement of the entrants' attributes differs (for example Census Region is nominal and AFQT Group is ordinal) all these variables are treated as if they were purely nominal. Thus the attribute vector (x) contains only "zeros" and "ones" with a "one" indicating that the i^{th} attribute is present for a particular observation. This has the principal advantage of allowing the individual effect of the specific attribute to be displayed directly as the estimated coefficient.

A second decision was required concerning whether to apply the model to the individual observations or to group those observations with the same set of characteristics. Owing to the large number of individual observations (nearly 180,000 for the three years data), grouping the observations had the principle advantage of reducing the expense of the computations. Moreover, it is well known that unbiased parameter estimates can be obtained from the grouped data.[14] For this reasons, we chose to group similar observations, and the resulting data consists of the proportion of non-attriters in each of 1280 cells.[15] The cost of this action is a loss in efficiency of the estimated parameters.[16,17]

The final issues concern the choice of functional form. The linear function,

$$(2) \quad P = B_o + B_1 X_1 + \ldots + B_k X_k + u$$

and the logistic function,

$$(3) \quad \ln \frac{P}{(1-P)} = B_o + B_1 X_1 + \ldots + B_k X_k + u$$

are the most widely used representations in the literature of the general function f(x) which seek to explain or to predict attrition for the services. For both functions, "u" represents a random error term, and the B_i's are the coefficients which, when estimated, determine the magnitude of the effect of the i^{th} attribute, X_1.

Each functional form has certain advantages. The linear form is simpler, and easier to interpret, since the estimated coefficients can be interpreted to represent the increase in probability of non-attrition when the corresponding attribute is present for an individual. The total probability of non-attrition, therefore, is the sum of the coefficients for the attributes for an individual. The principle objection to the linear form is that the predicted probability may fall outside the interval zero and one. The logistic function removes this objection because the implied probabilities given by,

$$\hat{P} = \frac{1}{1 + EXP(-\hat{B}X)}$$

necessarily fall in the zero/one interval. Additionally, the logistic form implies a signoid (s shaped) relationship between the probabilities and characteristics, a shape which is often found to better approximate the observed relationship than does the linear form. On the negative side,

the logistic is more difficult to interpret since the estimated coefficients determine only the shape of the "S" curve hence the probabilities of non-attrition must be derived from the equation form. Although the logistic is superior to the linear form on theoretical grounds, the ultimate choice between the two depends on how well each represents the data to which they are fitted. We chose to estimate both forms and compare the results.

A final difficulty was encountered in the estimation process as a result of our choice of using grouped observations. For both functional forms, grouping the original observations results in a non-constant variance of the error term, which produces a potential loss in efficiency of the estimated parameters. The theoretical variance of the linear form is,

$$(5) \quad \sigma^2_{u_i} = \frac{P_i\ (1 - P_i)}{n_i}$$

and for the logistic the theoretical variance is,

$$(6) \quad \sigma^2_{u_i} = \frac{1}{n_i\ P_i\ (1 - P_i)}$$

where, n_i = number of observations in i^{th} cell,

and, P_i = probability of non-attrition in the i^{th} cell.

The error terms may be transferred to constant variance by multiplying the original data by a weight equal to the square root of the inverse of theoretical variance.[18] These weights are,

$$(7) \quad \text{Linear:} \sqrt{\frac{n_i}{P_i\ (1 - P_i)}}$$

$$(8) \quad \text{Logistic:} \sqrt{n_i\ P_i\ (1 - P_i)}$$

where the theoretical probability P_i is replaced by the sample value. In both cases, the effect of this transformation is to weight cells with greater observations more heavily.

In summary, two weighted regressions were performed on the variables previously identified.[19] Weighting the regressions insures efficiency of the resulting estimate, and permits the empirical results to be compared.

ESTIMATION RESULTS

Table 3 presents the parameter estimates for the grouped linear model and Table 4 presents the corresponding estimates for the grouped logistic model. Both models yield consistent results in terms of the relationship between individual characteristics and the dependent variable, the probability of non-attrition. The estimated coefficients for the linear model represent the incremental increase or decrease in the probability of non-attrition relative to the constant WT when the corresponding attribute is present. WT represents the probability of non-attrition for an 18 year old mental group IVa caucasian with less than 3 years of high school who enlisted between January and June from the New England Census Region. The total probability of non-attrition for any given set of characteristics is WT plus the sum of the coefficients. Those characteristics having the largest positive coefficients will be the characteristics that will have the greatest impact on the dependent variable.[20]

A number of general conclusions emerge from the results of the linear model. First, years of education even among the non-high school population are positively and significantly associated with probability of non-attrition. Everything else being equal, an individual with 3-4 years of education has

TABLE 3

GROUPED LINEAR MODEL

VARIABLE		B VALUE	STD. DEV.	T VALUE
WT*		.4198	.011	38.1*
Race (Non-white)		-.0051	.004	- 1.1
3-4 Years High School, No Diploma/GED		.0841	.004	22.0*
Month Entered July-Dec		-.0084	.004	- 2.3
Age - 17		-.0445	.004	- 9.9*
Age - 19		.0137	.005	2.5
Age - 20		.0001	.005	.01
Mid Atlantic Census Region		-.0009	.011	- .09
E. North Central Census Region		-.0041	.010	- .40
W. North Central Census Region		.0001	.011	.01
S. Atlantic Census Region		.0201	.010	1.98
E. South Central Census Region		-.0033	.011	-0.29
W. South Central Census Region		.0135	.010	1.27
Mountain Census Region		.0509	.012	4.19*
Pacific Census Region		.0053	.010	.51
Other Census Region		.1798	.018	9.82*
AFQTG	IIIb	.0284	.006	4.76*
AFQTG	IIIa	.0585	.006	9.06*
AFQTG	I&II	.0902	.007	12.65*

d.f. = 1212 *Significant $p \leq .0001$

*WT = Probability of non-attrition for Caucasian, less than 3 years high school, enlisted Jan - Jun, Age 18, New England Census Region, AFQTG IVa.

TABLE 4

GROUPED LOGISTIC MODEL

VARIABLE	B VALUE	STD DEV	T VALUE
WT*	-.3120	.041	-7.60*
Race (Non-white)	-.0126	.016	- .77
3-4 Years High, No Diploma/GED	.3326	.014	23.84*
Month Entered, July - December	-.0318	.013	-2.39
Age - 17	-.1774	.016	-10.76*
Age - 19	.0495	.020	2.47
Age - 20	.0080	.022	.37
Mid Atlantic Census Region	-.0005	.038	- .01
E. North Central Census Region	-.0134	.038	- .36
W. North Central Census Region	.0321	.043	.75
S. Atlantic Census Region	.0767	.038	2.04
E. South Central Census Region	.0127	.041	-.31
W. South Central Census Region	-.0516	.039	1.32
Mountain Census Region	.2003	.045	4.44*
Pacific Census Region	.0171	.039	.45
Other Census Region	.5625	.078	7.24*
AFQTG IIIb	.1019	.022	4.56*
AFQTG IIIa	.2285	.024	9.45*
AFQTG I & II	.3483	.027	13.03*

d.f. = 1212

*Significant $p \leq .0001$

*WT - Caucasian, less than 3 years high school, enlisted Jan-Jun, Age 18, New England Census Region, AFQTG IVa.

a .0841 greater probability of not attriting than an individual with less than 3 years of high school education. Second, age is associated with attrition. Relative to an 18 year old a 17 year old has a .0445 greater chance of attriting. Alternatively 19 and 20 year olds are better relative bets not to attrit (probability .0137 and .0001 respectively). Third, census regions are associated with attrition probabilities. For example, non-high school graduates enlisting from the Mountain and Other census regions are better relative bets than individuals enlisting from the Mid-Atlantic, East North Central and East South Central regions. Finally, AFQT group standing is positively and significantly associated with non-attrition. Relative to an individual in AFQT group IVa an individual in the next higher test group IIIb has a .0248 greater probability of not attriting; an individual in group IIIa has a .0585 increased chance of not attriting, and an individual in group I or II has a .0902 increased probability of non-attrition.

The findings for the Army NHSG-NPS market segment are generally consistent with the previously cited research which focused on more aggregate market segment data. In addition to identifying those characteristics associated with relatively lower attrition risks in the NHSG-NPS segment, the second objective of this research was to evaluate the relative effectiveness of each model in predicting attrition for the FY76 cohort.

MODEL PREDICTION RESULTS

The practical utility of any predictive model or heuristic should be judged on how well it predicts. In order to compare the two model forms in terms of this criterion, each model was used to assess the probability of non-attrition for individuals possessing a like set of characteristics

in the FY76 enlisted NHSG-NPS Army cohort. These individuals were then evaluated by each model and a probability of non-attrition was estimated for each group. These groups were then ranked from the highest to lowest probability of non-attrition. Tables 5 and 6 present the results of these rankings for the grouped linear model and logistic model respectively. As Table 5 indicates, if the top 1,000 individuals based on highest estimated probability of non-attrition were enlisted the actual results of this decision would have been that 741 would not have attrited while 259 would have attrited prior to the end of their enlistment tour. For the logistic model, Table 6 the comparable figures would be 742 non-attrition and 258 attrition. Alternatively, if the top ranked 20,000 individuals were selected the grouped linear model yields would have been 13,523 non-attrition and 6,477 early attrition while the yields from the logistic model would have been 13,525 non-attrition and 6,475 attrition. As can readily be seen, the results of both model forms are almost identical in terms of actual yields when tested using the FY76 NHSG-NPS sample. Thus, although the logistic model form may be superior to the linear form on theoretical grounds a comparison of their results suggests little practical difference in terms of the actual yields that would have occurred by using the estimated probabilities as the basis for selection.

In addition to examining the results from the two model forms, two well known selection heuristics were also evaluated using the FY76 NHSG-NPS sample group. Tables 7 and 8 present the results of rank ordering individuals based on educational level and AFQT groupings respectively. For Table 7, individuals in the FY76 sample were ordered into two educational groups -- those that had completed 3-4 years of high school with no diploma, and those who had

TABLE 5

YIELDS FROM GROUPED LINEAR MODEL

TOTAL ENLISTED	TOTAL NON ATTRITION	TOTAL ATTRITION	MARGINAL ATTRITION RATE
1000	741	259	.26
2000	1485	515	.26
5000	3648	1352	.28
10000	6998	3002	.33
15000	10318	4682	.34
20000	13523	6477	.34
25000	16662	8338	.37
30000	19652	10348	.40
35000	22709	12291	.39
40000	25595	14405	.42
45000	28366	16634	.45
50000	31185	18815	.44
53580	33073	20507	.47

The average attrition rate in FY76 sample was 20,507/53,580 = .38

TABLE 6

YIELDS FROM LOGISTIC MODEL

TOTAL ENLISTED	TOTAL NON ATTRITION	TOTAL ATTRITION	MARGINAL ATTRITION RATE
1000	742	258	.26
2000	1479	521	.26
5000	3657	1343	.27
10000	6993	3007	.33
15000	10324	4676	.33
20000	13525	6475	.34
25000	16646	8354	.38
30000	19685	10315	.39
35000	22699	12301	.40
40000	25590	14410	.42
45000	28326	16674	.45
50000	31226	18774	.42
53580	33073	20507	.48

TABLE 7

YIELDS FROM EDUCATION LEVEL HEURISTIC

TOTAL ENLISTED	TOTAL NON ATTRITION	TOTAL ATTRITION	MARGINAL ATTRITION RATE
1000	695	305	.31
2000	1402	598	.29
5000	3530	1470	.29
10000	7027	2973	.30
15000	10053	4947	.39
20000	13372	6628	.34
25000	16648	8352	.34
30000	19626	10374	.40
35000	22638	12362	.40
40000	25535	14465	.42
45000	28106	16894	.49
50000	30891	19109	.44
53580	33073	20507	.39

TABLE 8

YIELDS FROM AFQ TEST GROUP HEURISTIC

TOTAL ENLISTED	TOTAL NON ATTRITIO	TOTAL ATTRITION	MARGINAL ATTRITION RATE
1000	648	352	.35
2000	1300	700	.35
5000	3210	1790	.36
10000	6820	3180	.28
15000	9776	5224	.41
20000	12941	7059	.37
25000	16043	8957	.38
30000	18954	11046	.42
35000	21534	13466	.48
40000	24596	15404	.39
45000	27591	17409	.40
50000	30747	19253	.37
53580	33073	20507	.35

completed less than 3 years of high school. Again, if the top 1,000 individuals were selected using education as the selection heuristic the actual outcome would have been that 695 would not have attrited while 305 would have attrited. The same logic was used in constructing Table 8. Individuals were ranked ordered highest to lowest based on their AFQT groupings and the yields using this selection heuristic were calculated.

DISCUSSION

A number of conclusions emerge from this analysis. First, individuals with different attribute profiles also differ with respect to their probability of attrition. Second, on a relative basis "good bets" can be differentiated from "poor bets" using either the grouped linear or logistic model form. Both model forms did equally well in prediction when tested on the FY76 sample. Third, both model forms do a slightly better overall prediction job compared to either the education level or AFQT group selection criteria.

The economic implications of the analysis involve tradeoffs with respect to attrition risks and cost, enlistment levels, and costs of additional recruiting effort. While recruiting in the NHSG-NPS segment exposes the DoD to increased relative attrition risks, these risks potentially could be managed in a number of alternative ways. One alternative would be to reduce attrition costs simply by trading off enlistment quantity for lower attrition risk. For example, by only enlisting the top 20,000 individuals in Table 7 the Army would have been able to reduce the average attrition rate from 38% to 32%. This alternative would seem to have limited appeal, however, given the current and projected recruiting shortfalls.

A second alternative designed to reduce expected attrition in NHSG-NPS segment would involve using the output of the predictive model as one additional source of input aimed at the early identification of potential "high risk" enlistees. Early identification coupled with organization counseling strategies could prove effective in improving an individual's chance of successfully completing a first term.

A third alternative would involve an attempt to reduce expected attrition and cost without sacrificing the quantity objective. The viability of this alternative hinges on an evaluation of the marginal costs of recruiting necessary to expand the NHSG-NPS applicant pool versus the expected benefits of reduced attrition that could result from being more selective from a larger pool. Table 9 shows approximate incremental cost savings that follow from different assumptions about average cohort attrition rates and attrition costs per individual. The figures in the Table are incremental figures relative to a base case assumption of an original NHSG-NPS cohort size of 50,000 and an attrition rate of 20,000 individuals (40%). For example if the attrition rate could be reduced from 40% to 33% total attrition would fall from 20,000 to 16,500. If the direct plus indirect attrition cost per individual is assumed to be $5,000 the gross incremental cost savings would amount to $17.5 million. This gross savings figure, in turn, would be offset by the marginal cost of additional recruiting required to expand the applicant pool.

As always, more analytical work needs to be done in a number of areas. Specifically, we need better estimates of the marginal costs to recruit a potential enlistee in the different market segments. Estimates to date suggest that these costs vary considerably as a function of market segment. For example, for the Army in FY77 the marginal cost of recruiting a male

TABLE 9

SENSITIVITY OF ATTRITION COST SAVINGS (Millions $)

Indirect & Direct Attrition Costs Per Individual

AVERAGE COHORT ATTRITION RATE	$1,000	$5,000	$10,000
38%	$1M	$5M	$10M
33%	3.5M	17.5M	35M
28%	6M	30M	60M

BASE CASE:

- Original Cohort Size = 50,000
  Attrition Rage = 40%
  (20,000 individuals)

high school graduate capable of scoring average or above on standardized entrance tests was estimated to be $3,700 while the marginal cost of recruiting other "lower-quality" males was estimated to be $150.[21] Do these marginal costs remain constant as search is expanded in any particular market segment? To what extent does quality degrade as recruiting intensifies in any particular market segment? If quality does degrade how does this effect the attrition risk for DoD? These questions must be addressed in order to gain a better understanding of the relative expected value of alternative recruiting cost/attrition risk tradeoffs between major labor market segments.

NOTES

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3. U. S. Department of Defense, Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics, Manpower Requirements Report for FY 1980, DoD, 1979.

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11. Schulcz, A. A., "The Army and Attrition." H. Sinaiko, ed., In First Term Enlisted Attrition - Vol 1. Conference Report TR-3, Smithsonian Institution, Washington, D. C., June 1977.

12. Reasons for separation are coded by using a standard Interservice Separation Code. Codes 60-87 (Failure to Meet Minimum Behavioral or Performance Criteria) were used to define attrition in this study. An expanded description of these codes can be found in: Master and Loss Files: Coding and Data Element Description, Attachment B, 20 July 1977. Defense Manpower Data Center, Monterey, California.

13. New England - CT, ME, MA, NH, RI, VT.: Mid Atlantic - NJ, NY, PA.; E. North Central - IL, IN, MI, OH, WI.; W. North Central - IA, KS, MN, MO, NE, ND, SD.; South Atlantic - DE, DC, FL, GA, MD, NC, SC, VA, WV.; E. South Central - AL, KY, MS, TN.; W. South Central - AR LA, OK, TX.; Mountain - AZ, CO, ID, MT, NV, NM, UT, WY.; Pacific - AK, CA, HI, OR, WA.; Other - Amer. Amoa, Quam, Puerto Rico, Canal Zone, Virgin Islands.

14. Haitovsky, Y., Regression Estimation From Group Observations. New York: Harper Press, 1973.

15. The number of cells in the product of 2 race categories, 2 education categories, 2 month entered categories, 4 age categories, 10 census region categories, and 4 mental group categories.

16. Haitovsky, Y., Regression Estimation From Group Observations. New York: Harper Press, 1973.

17. Lockman, R. F., and J. T. Warner, "Predicting Attrition: A Test of Alternative Approaches." H. Sinaiko, ed, In First Term Enlisted Attrition - Vol 1., Conference Report TR-3, Smithonian Institution, Washington, D. C., June 1977.

18. Pindyck, R. S., and D. L. Rubinfeld, Econometric Models and Economic Forcast." New York: McGraw-Hill, 1976.

19. The SYSREG OLS regression procedure from the Statistical Analysis System (SAS) was used.

20. In addition to the variables listed in Tables 5 and 6 a number of interaction terms were estimated. They included: (1) Race and Education, (2) Race and Age, (3) Education and Age, (4) Education and Census Region, (5) Race and Census Region. Only one, Race and Education was significant at $p \leq .05$ or better. While this term was statistically significant its coefficient (linear = -.000009; Logistic = .002) of little practical significance either model.

21. U. S. Department of Defense, Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics, Use of Women in the Military, Background Study, DoD, May 1977.

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